# FREEZE-DRYING EXPECTATIONS

*Is freeze-drying here to stay?

*Is there an immediate future for freeze-drying?

*What might be the effects of freeze-drying on food processors, warehousemen, wholesalers, retailers, the transportation, container and refrigeration industries?

These are million dollar questions in the food industries today. I don't have complete answers to them, and don't know of anyone who does. However, it is the job of an economist to make estimates, and this is what I'll be doing here. My answers are based largely on results of studies we are currently conducting in the Department of Agriculture.

## Definition of Freeze-Drying

Every person in the field would define freeze-drying a little differently. Here's mine, and it's general rather than a technical one:

> Freeze-drying is a drying method that removes moisture from frozen foods without appreciably changing the form, color or taste of the product. Moisture content of the finished food is reduced to 2 percent or less. After drying, the product is packaged to prevent oxidation and re-entry of water. Bacterial, mold, and enzymatic actions are kept to a minimum in the packaged product through control of oxygen and moisture. Reconstitution is done by adding water or other liquids.

Basically freeze-drying is changing frozen foods (cooked or uncooked) to dried food by sublimation. This means ice is removed directly from the frozen state to the gaseous state, bypassing the liquid phase. The

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sublimation process takes place in a vacuum chamber, at low pressure and controlled input of heat. If the process is done correctly, the food is not heated enough to cook or scorch it. Since only distilled water leaves the food, the resulting product has a definite advantage over other drying techniques in that the oils and other flavor-carrying liquids remain. So the flavors also stay in the food. So far, with the development of the industry, they have had good success with products such as shrimp, chicken, mushrooms and a few others.

Advantages of the Processing Method

Freeze-drying offers several unique advantages. When the product is properly prepared and controlled through the freeze-drying, the quality and trueness of flavor of the reconstituted food is said to equal that of frozen foods. Yet there is no need for refrigeration in handling, transportation, and storage. The shelf life is longer than for frozen foods. In addition there is a weight reduction exceeding that of other dried foods. For example, 100 pounds of cooked beef reduces in weight to 42 pounds; 100 pounds of mushrooms has a dried weight of 10 pounds.

There is one point, however, that has created an interest among people in the refrigeration industry. Here is a process that uses more refrigeration than frozen foods do in the processing stage (this is true only if mechanical pumps and condensers are used for water evacuation), but eliminates the need of refrigeration throughout the remaining stages of marketing of the product.

People other than refrigeration men are concerned about this possible effect on the refrigeration industry. Here I quote a chain-store man:

> "This is the kind of thing that scares me...(he is holding and referring to a package of freeze-dried camper food, now sold only in sporting goods stores)... What will it mean to the huge investments we are making today in refrigeration cases and refrigerated transportation equipment? The day will come when we can market this product successfully in food stores. It won't be tomorrow, or a year from now, but it will come. We've got to start considering its implications on the future." 1/

Before getting on with the job of answering the three questions we started with, let's discuss a few findings from our studies which may provide a basis for discussion:

How acceptable are freeze-dry products?

What are the costs of processing freeze-dry products?

First, let's talk about how good the products are.

## Quality of Freeze-Dried Foods

We have submitted to an expert taste panel samples of all the freeze-dried products now on the market. 2/ There are 23 different freeze-dry products under examination, and in all of the taste tests we compared each freeze-dried product with the same product processed in another way. The standard in most cases was either frozen or canned.

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1/ Quoted in Chain Store Age, October 1962, p. 87, from an interview with Mr. Carl Reith, president of Colonial Stores, Inc.

2/ Work in this panel was done by the Human Nutrition Research Division of the Agricultural Research Service, Beltsville, Maryland, summer of 1962.

Products were tested for general acceptability, and, then, specifically for appearance, flavor, texture, dryness, and tenderness. The results of the tests of flavor are shown in Figure 1. Complete results of all taste panel work will be released in the form of a bulletin.

On Figure 1, we show taste panel results for six products: Hamburger, chicken, scrambled eggs, shrimp, peas, and mushroom soup. These were selected to give a cross-section picture of foods now being commercially processed. To get a complete canvas of all freeze-dried foods now on the market it will be necessary to review our publication. 3/ All products were cooked before freeze-drying.

Flavor ratings

The hamburger had a similar score to the frozen standard. Both were rated "fair." Freeze-dried hamburger is retailed only in sporting goods stores.

Our flavor rating for the freeze-dried chicken is an average of all the several brands now on the market. Flavor-wise, chicken was between "poor" and "fair," while the canned product was judged "fair" to "good." Freeze-dried chicken is now being marketed by several firms, although not at retail except in soup mixes.

We could find no processed scrambled eggs being sold, and were forced to use fresh eggs for our comparison standard. Results showed flavor to be much superior in the fresh egg product. The surprising

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3/ The research publication will give general acceptability, flavor, appearance, texture, dryness and tenderness ratings for 33 different foods, all those now being sold on the commercial market. No brands are identified and the objective has been to test individual products to assist in assessing the potential of the industry. It will be released in a few months.

thing to me is that processed scrambled eggs showed up as well as they did under these severe comparison conditions.

Shrimp has been on the institutional market for quite some time. The test illustrated was for shrimp that had no sauce or other flavorings added. It was considered "fair" by the flavor testing and the frozen shrimp rated a "good." We also tested shrimp with creole sauce, cream sauce and salad dressing. The addition of other ingredients to the shrimp raised the score of both the freeze-dried and frozen shrimp to where it was virtually impossible to distinguish them from each other. The same upgrading occurred with other products tested, as chicken with cream sauce and crabmeat with salad dressing.

Frozen peas were judged to have much superior flavor to the freeze-dried peas. These peas were not on the market as a separate item, but came from a mix.

Our cream of mushroom soup estimate is an average of several brands. It was about equal in flavor to the canned mushroom soup comparison product. We found great variability between brands.

If I were to make any general statements concerning freeze-dried products, I would say poultry meat and several of the red meats have a good potential market. You have seen that cooked hamburger tested well, relative to frozen. Ham also showed up well. Several sea foods, particularly the shellfish, have already been market tested, and appear to be assured successes. Among the vegetables, asparagus, broccoli, brussel sprouts and several others have real potential. I am not a

horticulturalist and am not sure how to classify mushrooms, but I do feel sure the freeze-dry market is a natural for them and they will be freeze-dried in large quantities. Among the fruits I would guess that there is a market for most berries and also for some fruits. These seem to be earmarked for specialized uses as in the institutional trade or manufacturing. Many products like fish cakes, sausage products, stews, soups, desserts and even whole prepared meals come to mind as distinct possibilities. Speciality foods such as seasonings, spices, coffee, fruit powders and beer are promising items. Some of these are not far off in the future, either. A prominent coffee company is now installing seven freeze-dry cabinets in its instant coffee plant. Probably the freeze-dried product will be used to mix with the present instant coffee, and the resulting blend is expected to more closely resemble home-brewed coffee.

## A Look at Costs

The future of any industry is largely dependent on its costs. Freeze-drying is no exception. Our study is designed so we can look at freeze-dry costs from many different angles. In this analysis we were not concerned with the cost of freezing, packaging, warehousing, shipping, selling or promotion. Nor did we attempt to include product costs nor the costs of the package itself.

Let's look at one hypothetical freeze-drying operation. This plant has a capacity of handling 4 tons of water per day. It is operating on a 24-hour day, and has an 8-hour drying cycle. Equipment

depreciation is 16 percent. Labor costs are assumed to be about what they would be in a medium-sized midwestern city. The product to be dried is cooked chicken dices with 56 percent moisture. It is dried to 2 percent moisture.

Figure 2 illustrates freeze-drying costs if this hypothetical plant were operated at varying number of days per year. Here we assume that a full year of operating is 250 working days and 125 days would be equivalent to operating the plant at half-capacity. Costs were 11 cents per pound of water removed for the half-capacity volume. They are eight cents per pound of water if the plant is running at full capacity.

Other conditions yield different costs. For example, our largest model plant under study (not shown) has a capacity of 32 tons of water per day. Comparable costs to those quoted above were seven and four cents per pound of water. Mushrooms, having a much higher percentage of water (92%) showed costs considerably less than those quoted above for chicken. 4/

## The Future of Freeze-Drying

With results of our studies we can now hazard some answers to the original three questions. First the question,

"Is freeze-drying here to stay?"

It is! During the past year I have talked with representatives of the major food firms in this country. Most of these were management men. Practically all had an interest in freeze-drying; many have investigated

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4/ Complete details of this cost study will be published later in the year. Products analyzed include chicken, beef, mushrooms and shrimp.

the possibilities of freeze-drying, as it might apply to their business, and have decided against their company adopting this new technique. However, almost every one of them feels that there is a definite future for this industry. They are testing products, calculating costs, watching developments and waiting. Others have made a decision to freeze-dry, and many magazine articles attest to their enthusiasm.

Now to answer question number two,

"Is there an immediate future for freeze-drying?"

In our taste testing, some of the products showed up well. Others leave something to be desired. All products are not uniformly good, and we have found significant differences in the same food manufactured by different companies.

Our cost study results tell us that costs are high. However, we have found that costs may be lowered under certain conditions. Factors found to be especially important are material handling methods, length of the drying cycle, hours the plant operates per day, days per year (as illustrated), moisture of raw product, and capacity of the plant. This last one is called "economy of scale" by economists, and is extremely important. Our study shows that in plants of very large volume, costs become low enough so they could be somewhat competitive with other drying methods in the foreseeable future. It might be mentioned in this connection that costs of freeze-drying can never be expected to be lowered so they are comparable to those of freezing and

canning. This is because, in freeze-drying the product first has to be frozen, as is done for a frozen product, and must be packaged in a can or an expensive pouch. Thus, a freeze-dried product is frozen, then freeze-dried, and then canned.

However, we must consider costs other than processing ones. It is quite possible that transportation, handling or storage costs may be enough lower in freeze-dry products that they could more than offset the higher processing costs involved. Thus, it is the total marketing costs that are important rather than only processing costs.

My answer to the question,

"Is there an immediate future for freeze-drying?"

is yes. The industry is already here! There are some 30 odd products now on the market. Eight companies are in commercial production, and at least three of these are presently enlarging or modernizing their present plants. Four plants are now being built in this country and two in Canada. Six equipment companies are engaged in designing, building and installing equipment in this country and three are active in Europe. There the interest is as great as it is here.

How big will the industry ultimately grow? This is anybody's guess at this time. Two months ago I estimated that by 1970 the industry would have a retail sales volume of between one-half and one billion dollars annually. So far I have no reason to lower this estimate. Others are estimating a volume as large as two billion dollars annually.

Now to the last question,

"What will be the effect of freeze-drying on various other industries?"

I don't know. I have no idea to what extent freeze-drying might cut into the frozen food or canning industries. On the basis of our taste tests and cost studies, however, I would not be overly worried about the immediate future if I were a frozen food processor or canner. Frozen foods and canned items still have cost and taste advantages that will be hard to overcome. There will be particular products, though, in which freeze-drying has an advantage. A frozen food processor should bear in mind that every one of these freeze-dried products was first frozen, and this should remind him that this new processing method could actually provide a market for frozen foods. We should all bear in mind that procuring the product, preparing it for processing, warehousing, storage, promotion, selling and distribution are all integral parts of this complex marketing system. These functions are essentially the same for most products and they will not change greatly if freeze-drying does expand. A concluding statement is that undoubtedly freeze-drying will have direct and side effects that will be felt over the whole field of food processing. What they will be and their magnitude is difficult to appraise since the industry is new.

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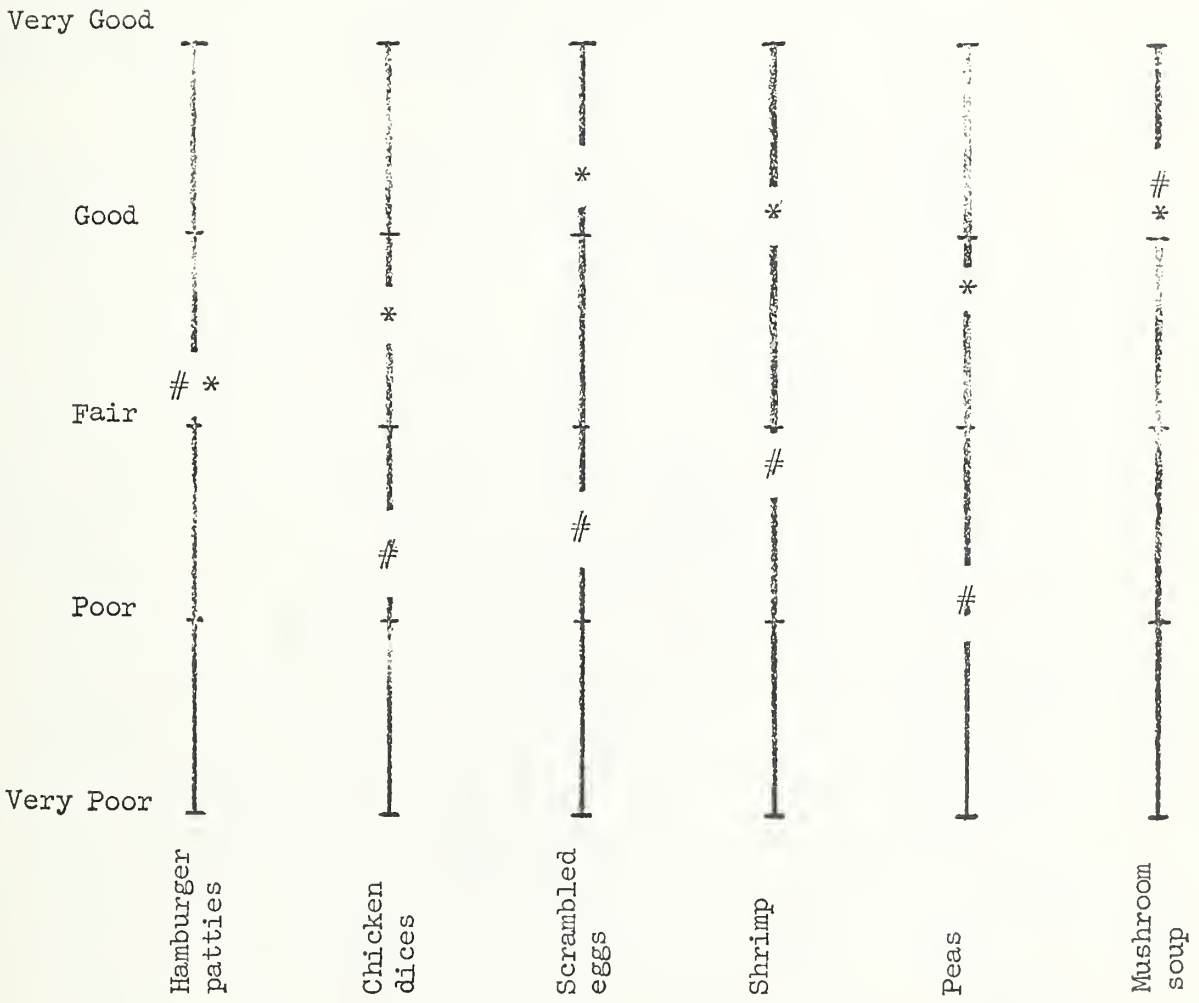
Additional copies of this speech may be obtained by writing to: Kermit Bird, Marketing Economics Division, Economic Research Service, U. S. Department of Agriculture, Washington 25, D. C.

Also available are copies of F-D Report No.1, "Freeze-Drying, Progress and Problems".

TASTE TESTS

Flavor Ratings of Freeze-Dried Products

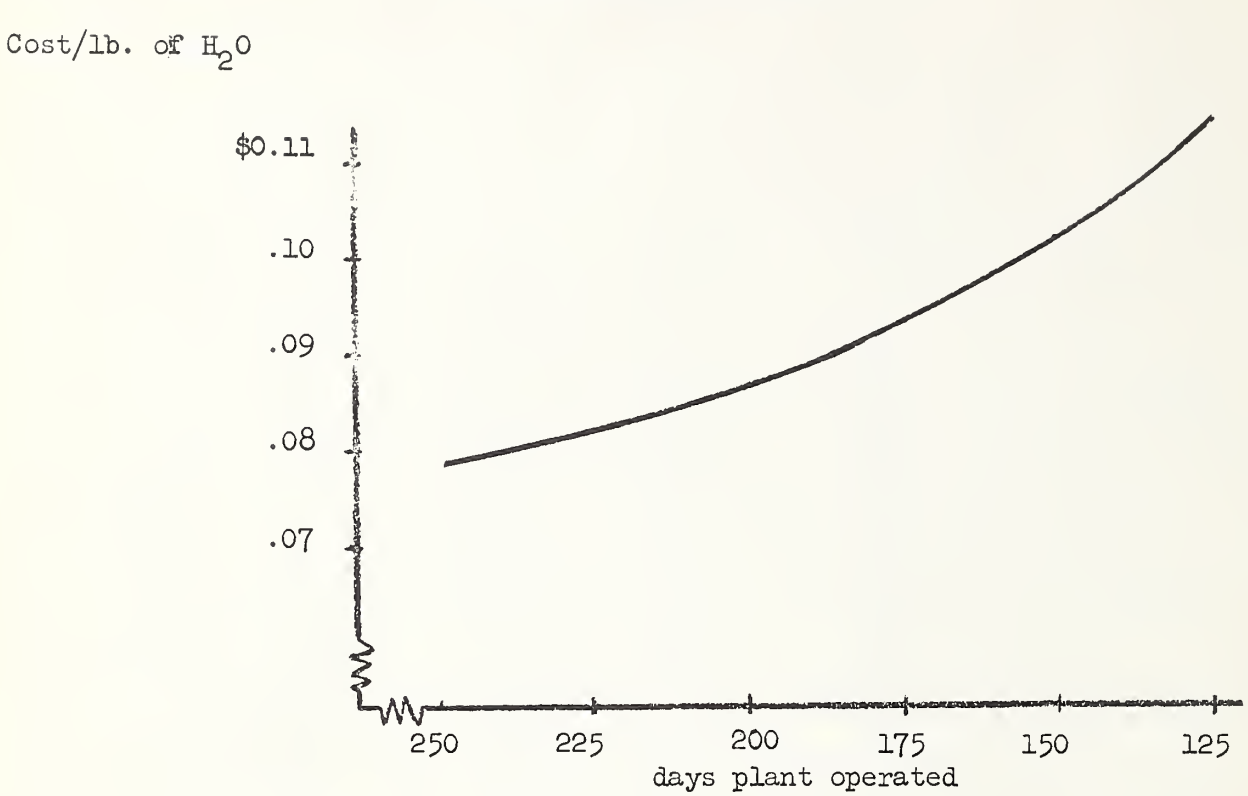



#=Freeze dried.
*=Comparison standard.

NOTE: Five trained testers tasted each product for three replications.

Figure 1

Freeze-Drying Costs Showing Effect
of Days of Operations*




*This curve is derived from synthetic data. Assumptions are: the product is cooked chicken, a 24-hour day of operation, an 8-hour drying cycle, plant has a capacity of 4 tons of water per day, use of mechanical refrigeration and condensers for water evacuation, raw product has 56 percent moisture, dried product has 2 percent moisture, three labor shifts per day, equipment depreciated in five years with a 20 percent salvage value.



Figure 2